Building and Environment 46 (2011) 1863–1871

Contents lists available at ScienceDirect

Building and Environment

journal homepage: www.elsevier.com/locate/buildenv

Basic building life cycle calculations to decrease contribution to climate change – Case study on an office building in Sweden

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ARTICLE INFO

Article history:
Received 27 August 2010
Received in revised form
7 February 2011
Accepted 8 February 2011

Keywords:
Building design
Climate change
CO_2 emissions
Life cycle tool
Energy use
Materials impact

ABSTRACT

This study examined whether simplified life cycle-based calculations of climate change contributions can provide better decision support for building design. Contributions to climate change from a newly built office building in Gävle, Sweden, were studied from a life cycle perspective as a basis for improvements. A basic climate and energy calculation tool for buildings developed in the European project ENSLIC was used. The study also examined the relative impacts from building material production and building operation, as well as the relative importance of the impact contributions from these two life cycle stages at various conditions.

The ENSLIC tool calculates operational energy use and contributions to climate change of a number of optional improvement measures. Twelve relevant improvement measures were tested. The most important measures proved to be changing to CO_2 free electricity, changing construction slabs from concrete to wood, using windows with better U-values, insulating the building better and installing low-energy lighting and white goods. Introduction of these measures was estimated to reduce the total contribution to climate change by nearly 50% compared with the original building and the operational energy use by nearly 20% (from 100 to 81 kWh/m^2 yr). Almost every building is unique and situated in a specific context. Making simple analyses of different construction options showed to be useful and gave some unexpected results which were difficult to foresee from a general design experience. This process acts as an introduction to life cycle thinking and highlights the consequence of different material choices

1. Introduction

The European Union has agreed upon climate targets to decrease the emissions of green house gases by 20% by 2020 and 50% by 2050 compared with the 1990 level [1]. Over and above that, the Swedish Parliament has decided that fossil fuels for heating purposes must be phased out by 2020 and that emissions of CO_2 must be reduced by 40% compared with 1990 (Swedish National Environmental Objectives) [2,3]. The building and property sector is regarded as an area where there are large possibilities to reduce energy use and contributions to climate change.

In Sweden, the building and property sector (including heating) emits around 15 Mton CO_2eq/yr, which constitutes approximately 20% of the total Swedish green house gas emissions [4]. To date, in some countries such as Sweden, the policies and building sector strategies have focused almost entirely on the building use stage in attempts to reduce the energy use and the contributions to climate change. This priority is supported by many case studies in which environmental impacts throughout the building life cycle have been calculated e.g. in studies studying on new office and residential buildings [5–7] and showed that about 80% of a building's total impact comes from the use stage. However, the variation between buildings is large. A review of case studies by Sartori and Hestnes [8] showed that in conventional new office and residential buildings the use stage accounted for 62–98% of the energy use over the life cycle, while in low-energy buildings, the use stage accounted for 54–91%. In a study on contributions to climate change, Marsh et al. [9] found that the use stage accounted for 40–95% in a number of different new, buildings in Denmark.

However, especially with the recent increase in interest in low-energy buildings, a number of studies have highlighted the importance of the environmental impact caused by construction material production [10–14]. For example, Ding [13] showed that in

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doi:10.1016/j.buildenv.2011.02.003